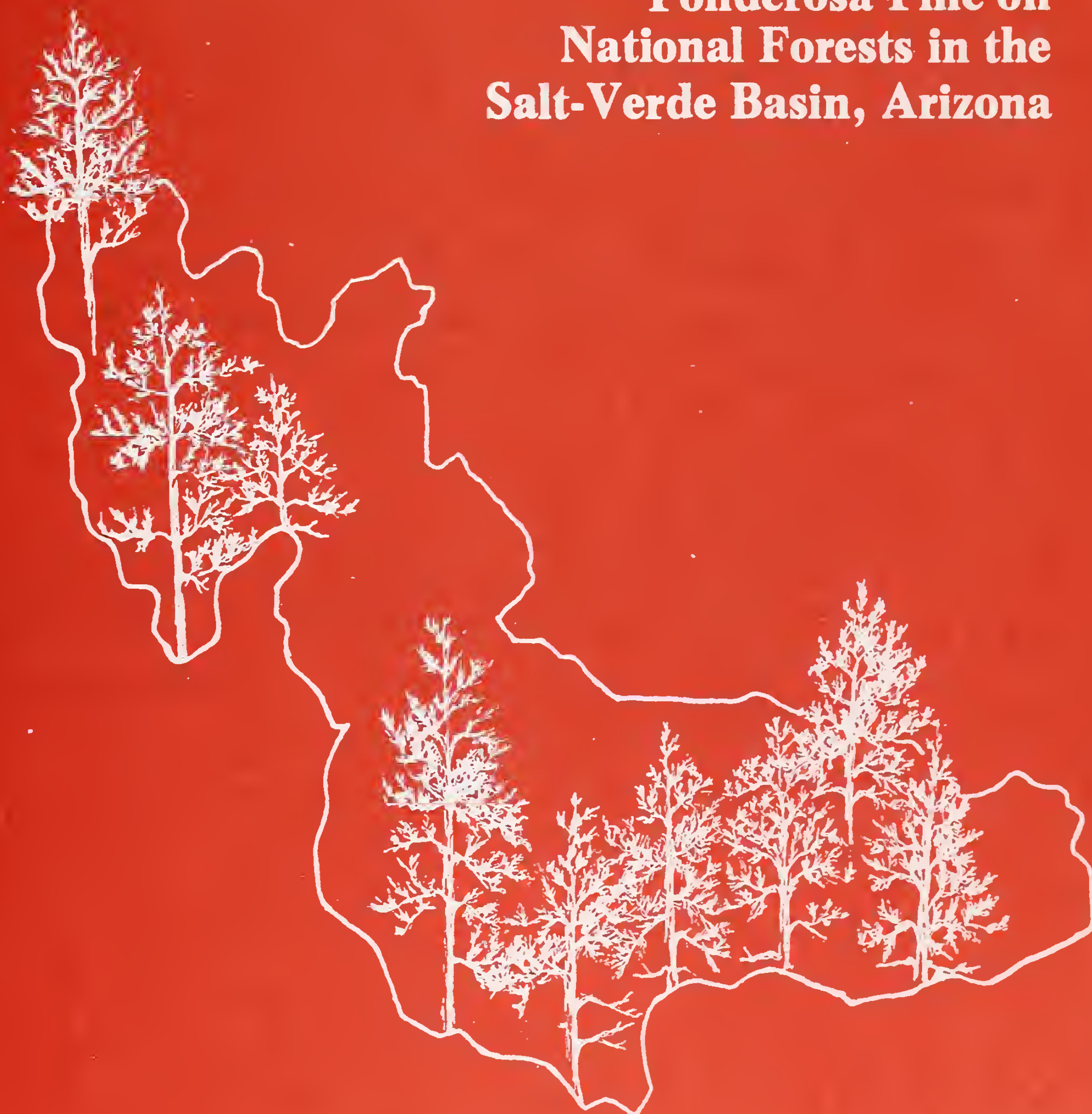
USDA Forest Service
General Technical Report RM-26

June 1976

A Descriptive Inventory of Ponderosa Pine on National Forests in the Salt-Verde Basin, Arizona



Rocky Mountain Forest and
Range Experiment Station
Forest Service
U.S. Department of Agriculture
Fort Collins, Colorado 80521

Abstract

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Keywords: *Pinus ponderosa,* Salt-Verde Basin.

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A Descriptive Inventory of Ponderosa Pine on National Forests in the Salt-Verde Basin, Arizona

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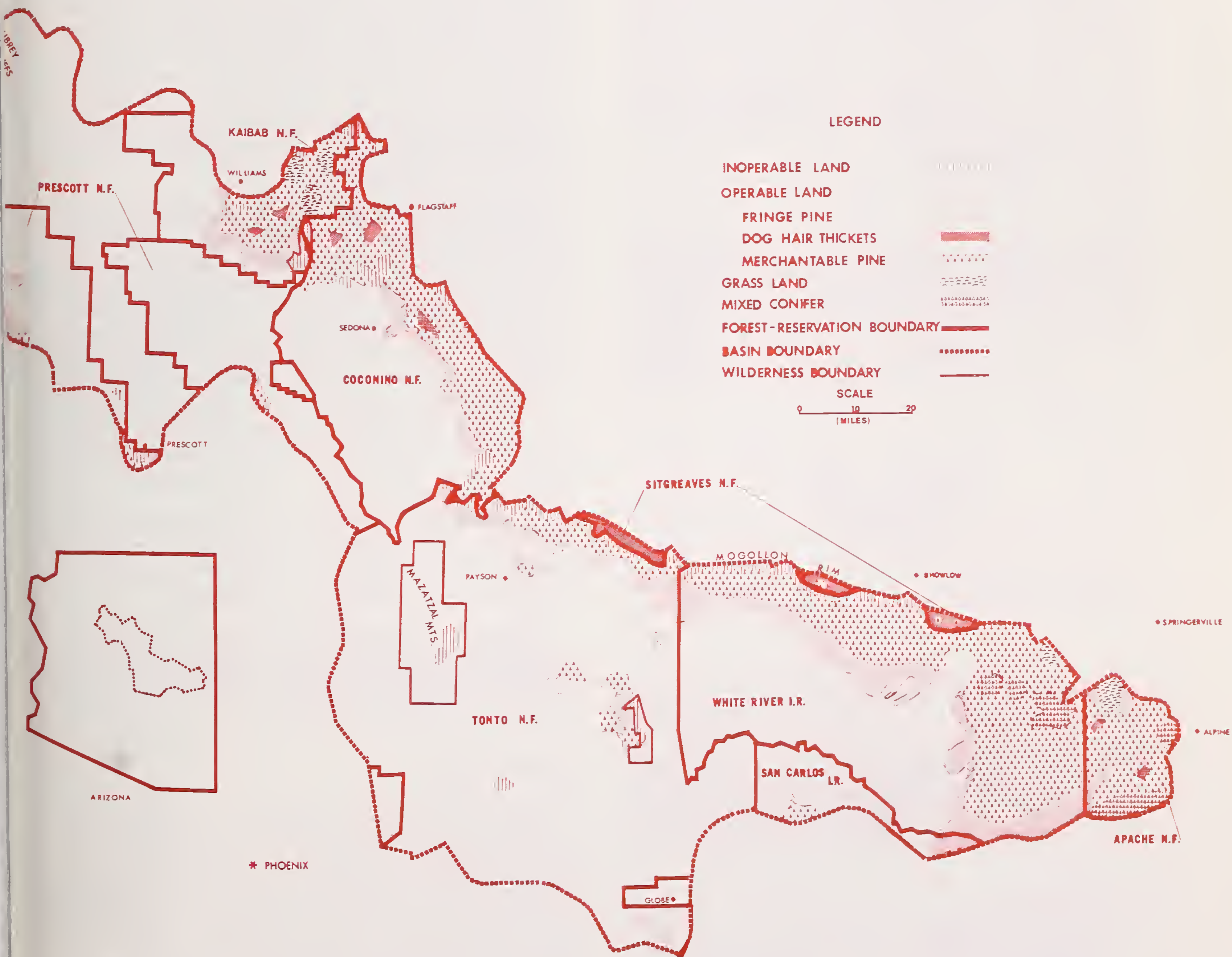
Contents

A Descriptive Inventory of Ponderosa Pine on National Forests in the Salt-Verde Basin, Arizona

Objectives

More intensive land use planning will require better evaluation of resource management alternatives. A primary consideration in the evaluation process is knowledge of the current resource base.

The purpose of this survey was to describe the commercial ponderosa pine within the Salt-Verde Basin, Arizona (fig. 1). Continuous forest inventory (CFI) information provided the data base. Although CFI data exist for all major Basin ownerships, this inventory analysis was limited to ponderosa pine on National Forest lands.



This inventory will not replace pre-timber sale compartment examinations. Instead, it will be used as a base for evaluating broad management alternatives for the National Forest ponderosa pine area within the Basin.

Commercial Forest Land Components Defined

The specific components of the commercial forest land are based on the land's productivity and logging capability. Lands currently producing, or capable of producing, a minimum of 20 cubic feet of industrial wood fiber per acre per year (Green and Setzer 1974) are defined as commercial forest land (CFL).

Ponderosa pine covers over 90 percent of the National Forest CFL in the Basin (table 1). Ponderosa pine occurs either in pure stands or in mixed stands primarily associated with Douglas-fir, pinyon pine, alligator juniper, aspen, and Gambel oak. The delineated area is essentially a continuous forest extending for over 225 miles along the Mogollon Rim in central Arizona (fig. 1).

Table 1.--Total area of commercial forest land (CFL) in Arizona (Green and Setzer 1974)

Location	Ponderosa pine		Mixed conifer[1]		Total CFL
	M acres	*%*	*M acres*	*%*	*M acres*
Salt-Verde Basin	1,610	90.6	168	9.4	1,778
Other	1,628	87.6	231	12.4	1,859
Total	3,238	89.0	399	11.0	3,637

[1]Includes aspen, Douglas-fir, white fir, corkbark fir, white pine, blue spruce, and Engelmann spruce.

Commercial forest lands are either inoperable or operable. Currently, the distinction between these two components is based on the presence or absence of constraints associated with sawtimber logging; however, future operability restrictions could be based on different land use and timber product constraints. Commercial forest land is classified as follows:

Inoperable
- Physical restrictions
- Land use constraints
- Administrative directives

Operable
- Nonstocked
- Fringe pine
- "Dog hair thickets"
- Merchantable production

Inoperable Land

Inoperable lands are defined by the existence of logging constraints, which are further classified into their specific operational restrictions: physical, land use, and administrative.

Physical restrictions are primarily those that limit the operation of logging equipment. Steep slopes (greater then 35 percent), excessive surface rocks, and the lack of road and skid trail systems reduce the operable area. Current stumpage prices prohibit the use of more expensive logging techniques; however, future timber prices may change this situation. "Inoperable lands" in forestry are analogous to "proved reserves in oil." As the price of oil goes up, so do the proved reserves. Likewise, higher prices for wood decrease the amount of inoperable and increase the amount of operable land.

Land use constraints result from selecting the best possible management alternative for a specific planning area within a multiple use framework. Alternative uses are dictated by soil characteristics, ecological impacts, and economic and sociological considerations. Land use areas defined as inoperable in this paper are those where alternative multiple uses prohibit or severely restrict timber harvesting.

Physical and productivity properties of soil may also restrict logging operations. Ecological impacts are equally important, and include considerations for fauna, flora, and water, travel, recreation, and amenity influence zones.

Economic and sociologic factors are interlaced with the other considerations. Alternative management decisions must consider the tradeoffs that result in various amenity-commodity combinations.

Administrative directives supersede land use restrictions, and often result from legislative mandates. Examples are wilderness areas (permanent or proposed) and research study areas.

Operable Land

Operable commercial forest land is defined as the residual land remaining after the inoperable lands are withdrawn from the total CFL. The physical character of the land permits use of current logging techniques. Environmental, economic, and sociological considerations do not prohibit logging, but provide the basis for alternative decisions among methods and intensities of logging.

Operable land is characterized by a spectrum of productive capabilities. This inventory divides the operable land into four production components: nonstocked, fringe pine, "dog-hair thickets," and merchantable.

Nonstocked land is defined as operable land area capable of but not currently producing wood fiber. This area needs reforestation by artificial or natural regeneration techniques.

Fringe pine areas are characterized by scattered, limby pines producing poor quality wood at a rate near the lower limits of the commercial forest land definition. This pine component is heavily mixed with understories of pinyon pine, juniper, and Gambel oak. Fringe pine occurs primarily as a transition zone between the merchantable pine and the chaparral and pinyon-juniper vegetation types (see fig. 1). Site Class III[2] lands predominate, and typify the poor site conditions found in this component.

"Dog-hair thickets" (dense stands with basal areas exceeding 150 ft^2 per acre) of precommercial size classes cover scattered areas within the Basin. Wood production per acre may be classified as adequate, but the production per tree often falls below the site capabilities. Many of these stands have maintained this stagnated condition for over 50 years and have yet to reach pulp and sawtimber size classes. These thickets are evident on lands throughout all site class ranges.

[2]*Site Class III, II and I include site index ranges 0-54, 55-74, and 75+, respectively.*

The **merchantable production** component is defined as the area which contributes the major portion of the harvest volume. The lands are primarily Site I and Site II areas. Current harvesting includes primarily pulp and sawtimber wood products; future harvests are expected to include a larger product variety.

Data Sources and Collection Methods

Descriptions of ownership, composition, distribution, and production were developed from a wide range of sources in order to delineate distinct soil productivity groups and corresponding stand tables for each forest.

Vegetation and Ownership Stratification

The pine vegetation areas were delineated on maps (scale: ½ inch = 1 mile) (Brown 1973), and the commercial pine component verified with National Forest personnel. Ownership of the commercial pine component (fig. 2) was stratified using National Forest and U.S. Geological Survey topographic maps. Additional information was obtained from Forest personnel and from previous publications (Barr 1956, Ffolliott et al. 1972, Green and Setzer 1974).

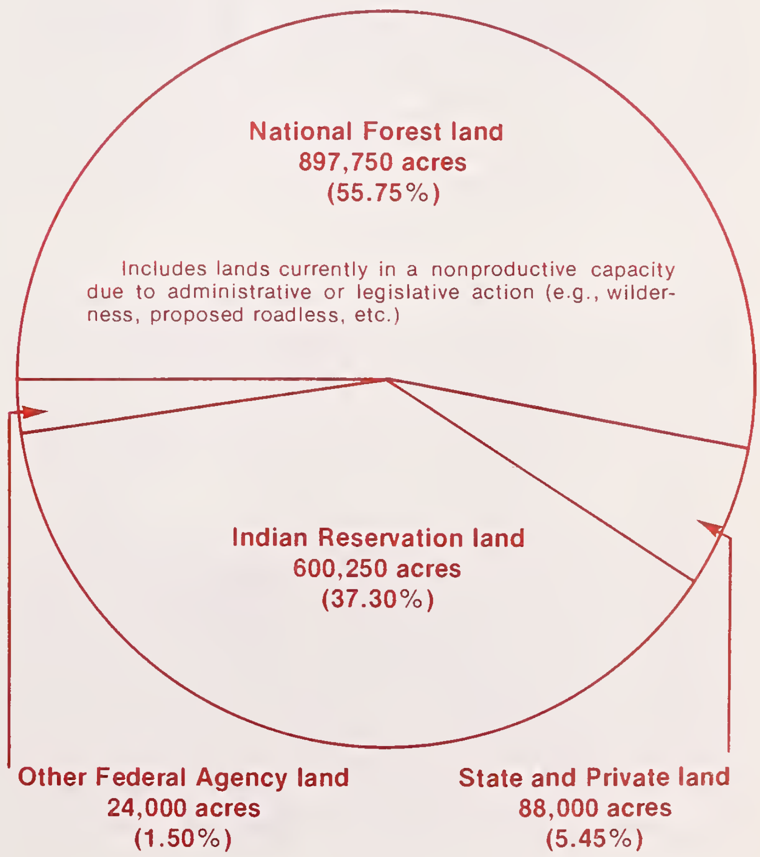


Figure 2.—Ownership patterns of the ponderosa pine commercial forest land in the Salt-Verde Basin, Arizona.

Soil Analysis

The objective of the soil analysis was to group soils with similar timber productivities. Frequency distribution curves of site index from continuous forest inventory data points were plotted for the soils within each National Forest. Figure 3 shows hypothetical examples of the frequency curves found to exist for igneous and sedimentary soils. Metamorphic formations constituted less than 1 percent of the Basin commercial forest area, and were eliminated from further consideration.

Igneous soil distributions formed distinct groups, which were related to specific soil types (for example, Springerville, Brolliar, and Sponseller). Site index variability was related to differences in soil properties such as soil depth, infiltration capacity, and rockiness. The distributions were not of equal size, but each represented only one soil type. Distributions overlapped at the lower frequency levels (fig. 3).

Sedimentary soil distributions did not exhibit distinct groups (for example, Cherry Creek, Dandrea, and Zane, fig. 3). Sedimentary site index variation was not evident *between* soil types but rather *within* soil types. The site index differences within soil types result from physiographic characteristics such as slope, aspect, and elevation.

The frequency distribution curves illustrated the range in site index for each soil type and facilitated

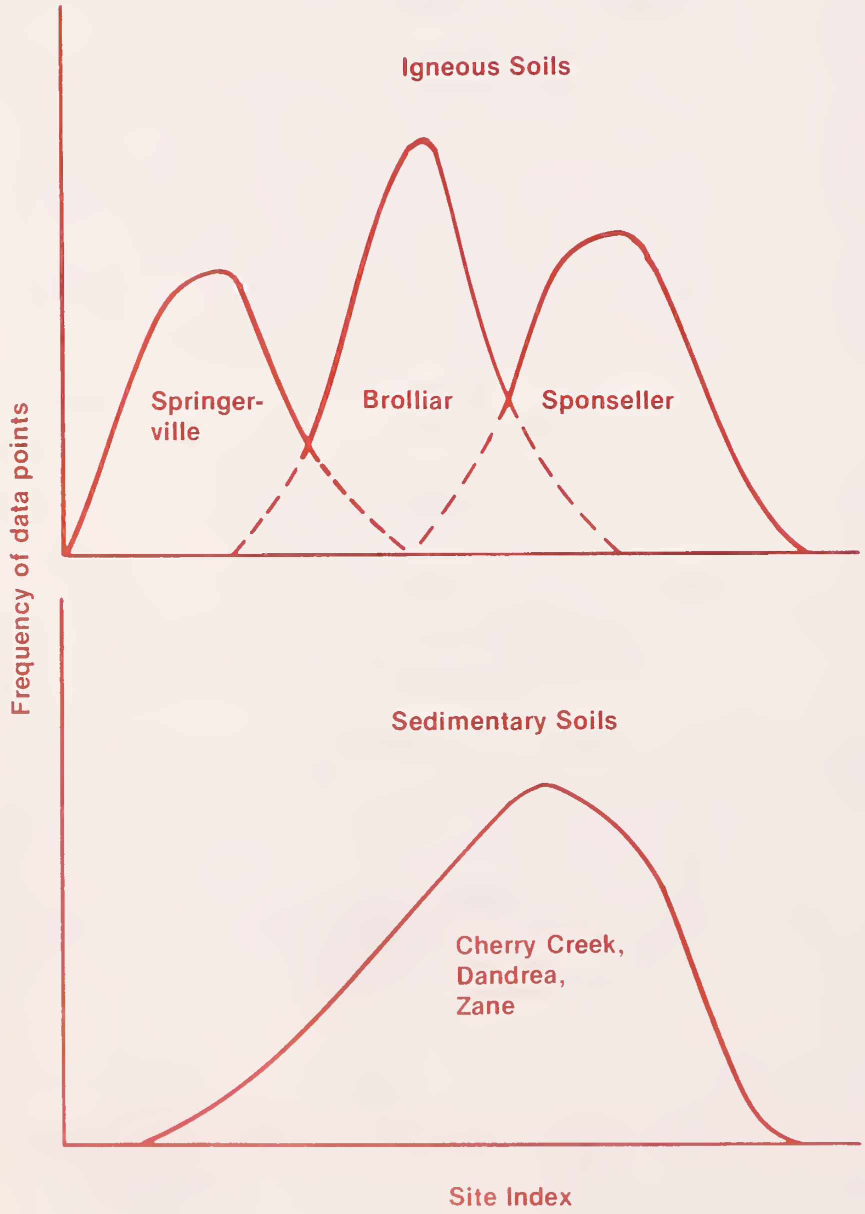


Figure 3.—Hypothetical site index frequency distribution curves.

determination of the average site index.[3] Combining soils having similar average site indices resulted in 14 soil productivity groups.[4] The areas represented by each group were delineated and overlaid on the commercial forest maps previously developed. Stand areas in acre units were determined using a planimeter.

Stand Table Analysis

Stand character descriptions were developed for each of the 14 soil groups.[5] Maps showing the Continuous Forest Inventory (CFI) ground plot points were overlaid on the previously developed soil maps. All CFI points within each soil group were averaged together to develop stand tables showing trees per acre by 2-inch diameter classes (seedling to 40 inches). Average stand basal areas and board-foot volumes were computed from the CFI data. There was no significant difference in stand basal areas and board-foot volumes computed using a computer simulation model for ponderosa pine growth (Larson 1975). CFI inventory dates and number of data points within the Basin were:

National Forest	Inventory date	Number of data points
Apache	1965	81
Coconino	1969	97
Kaibab	1966	83
Prescott	1970	49
Sitgreaves	1971	16
Tonto	1968	98
Total		424

Commercial Forest Land Component Analysis

After the stand table descriptions were completed, estimates of the various productive components of the CFL were developed (fig. 4). The primary sources included communication with National Forest and foresty industry personnel. Every attempt was made to gather all known information on the inoperable, nonstocked, fringe pine, dog hair thicket, and merchantable production components. Personal field trips helped verify and describe the components.

[3]The weighted average site index for each soil type was computed from: $\Sigma f_i x_i / \Sigma f_i$ *where x = site index, and f = frequency of data points.*

[4]The old Apache and Sitgreaves National Forests were kept separate because of their distinct differences in soil and timber density characters.

[5]Stand character is also highly related to past management influences. These stand descriptions should be considered as a first approximation until logging history data are utilized to further describe their variation.

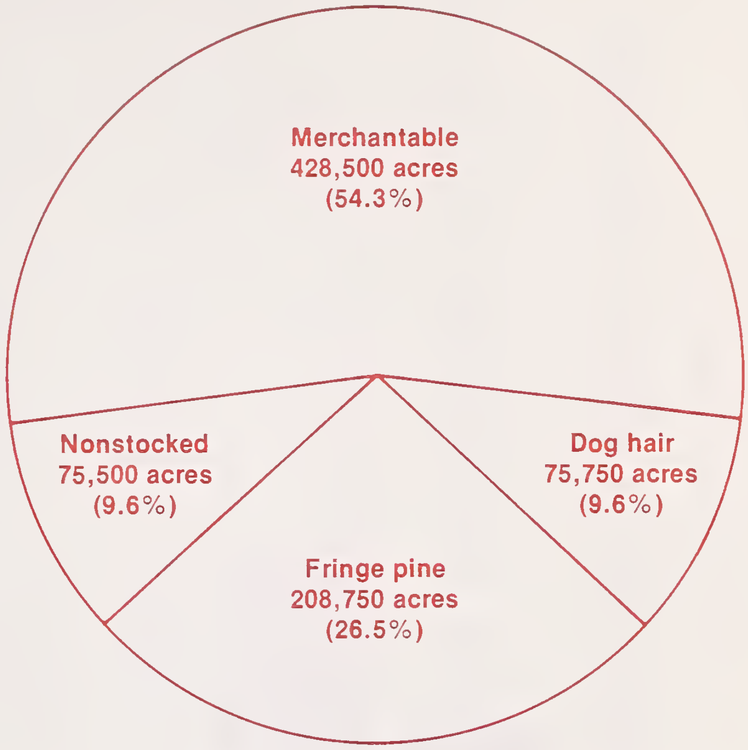


Figure 4.—Operable components of the National Forest ponderosa pine commercial forest land in the Salt-Verde Basin, Arizona.

Nonvegetative Information

Additional inventory information on nonvegetative characteristics was gathered to be used as input for forage and runoff estimates. U.S. Geological Survey topographic and precipitation (1931-60) maps and forest soil reports provided measures of slope, soil depth, annual precipitation, and winter precipitation.

Results

General Area.—The total commercial forest land (CFL) in Arizona is 3.64 million acres (Green and Setzer 1974). The Salt-Verde Basin contains 48.9 percent (1,778,000 acres) of the total, with ponderosa pine comprising 90.5 percent (1,610,000 acres) of the Basin CFL.

National Forests.—The total CFL under Forest Service jurisdiction is 897,500 acres, with 12.2 percent classed as inoperable at this time. The operable land (788,500 acres) is subdivided into nonstocked (75,500 acres), fringe pine (208,750 acres), dog hair thickets (75,750 acres), and merchantable (428,500 acres) (fig. 5). The Coconino National Forest has 44.3 percent (349,500 acres) of the Basin operable CFL, while the Sitgreaves National Forest has only 2.2 percent (17,500 acres) (fig. 5). The proportion of

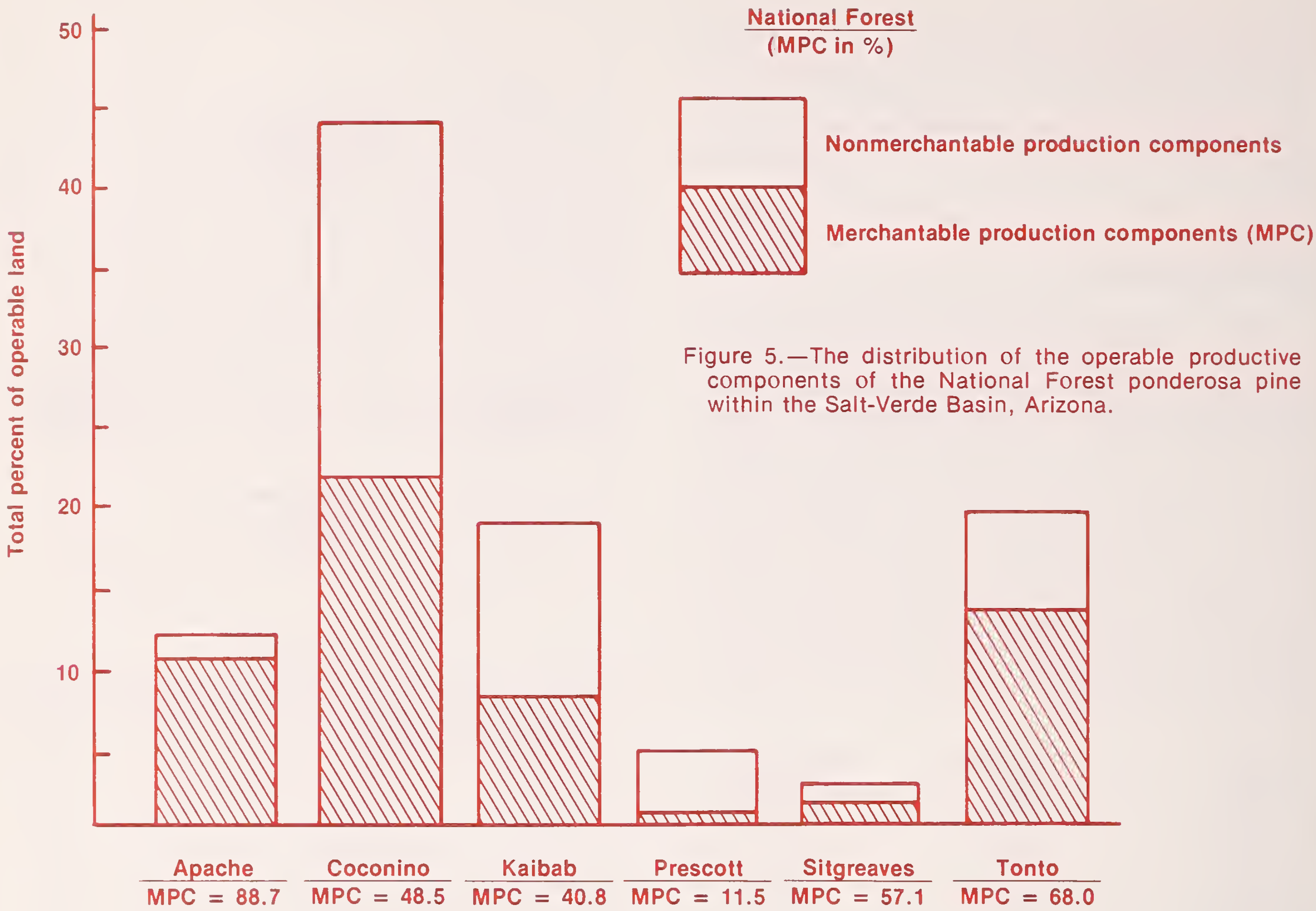


Figure 5.—The distribution of the operable productive components of the National Forest ponderosa pine within the Salt-Verde Basin, Arizona.

merchantable to nonmerchantable land varies among the Forests. For example, relative to the total operable land, the Apache National Forest has the highest percentage of merchantable production component, 88.7 percent (83,000 acres), while the Prescott National Forest has the lowest percentage, 11.5 percent (3,500 acres). The relationships of the other National Forests are shown in figure 5.

Soil Type Distribution.—The National Forest timber soils are derived from igneous (67.6 percent) and sedimentary (32.4 percent) geologic formations. Geological soil formation importance can be realized by comparing the total individual soil CFL area to its total merchantable production area. The Sponseller soil complex covers 12.8 percent of the total Basin operable CFL, but supports 20.4 percent of the merchantable component. Without exception, all of the sedimentary soils support a larger percentage of the merchantable component (39.4 percent) than the CFL lands (32.4 percent). The increases noted are related to the percentage of nonstocked, fringe pine, and dog hair acreages, which is smaller than on the poor soil types (Brolliar/Stoneman, Springerville/Thunderbird/Cabezon variants). Table 2 depicts this relationship for all of the major timber soil types found in the Basin.

Table 2.--Soil type distribution for the total operable commercial forest land (CFL) and the merchantable production component (MPC) ponderosa pine on the National Forests within the Salt-Verde Basin

Geological formation and soil type	Percent of total CFL	Percent of total MPC
Igneous	67.6	60.6
Sponseller	12.8	20.4
Brolliar/Stoneman	50.6	39.7
Springerville/Thunderbird Cabezon variants	4.2	0.5
Sedimentary	32.4	39.4
Soldier	3.7	5.5
McVickers	6.7	8.8
Amos, Bearhead, Mirbal Reynolds, Workman, and Zane	7.6	10.8
Cherry Creek, Colcord, Dandrea, Diamond Rim, and Verde	14.2	14.3

Table 3, 4, and 5 show acreage components, stand table descriptions, and stand compositions, respectively.

Table 3.--Ponderosa pine commercial forest land (CFL) acreages for the National Forests within the Salt-Verde Basin[1]

National Forest and Group No.	CFL Totals	Inoperable lands[2]	Operable lands			
			Nonstocked	Fringe pine	Dog hair	Merchantable
	Acres					
Apache						
1	51,000	1,500	500	1,500	2,000	45,500
2	45,000	1,000	1,000	2,500	3,000	37,500
Coconino						
3	34,500	4,800	1,200	3,500	1,500	23,500
4	46,500	7,400	1,800	5,500	2,000	29,800
5	278,000	26,800	27,000	80,000	30,500	113,700
6	34,000	4,500	13,000	13,000	1,000	2,500
Kaibab						
7	13,500	1,400	500	2,000	1,500	8,100
8	112,000	1,300	10,000	29,000	22,500	49,200
9	25,000	1,800	11,500	9,000	500	2.200
Prescott						
10	39,000	8,500	4,000	22,750	250	3,500
Sitgreaves						
11	19,000	1,500	2,000	1,500	4,000	10,000
Tonto						
12	95,450	35,450	800	10,900	2,200	46,100
13	99,300	11,800	1,650	24,400	4,550	56,900
14	5,500	1,500	550	3,200	250	0
Total	897,750	109,250	75,500	208,750	75,750	428,500

[1]Enclosed private and State lands deducted.
[2]Wilderness and research study areas are included.

Table 4.--Average productivity group descriptions

National Forest and Group No.	Geologic formation[1]	Soil productivity group (var. = variants)	A1 soil horizon depth	Annual precipitation	Winter precipitation	Insolation decimal	Site index	No. of trees	Basal area	Stand d.b.h.	No. of cords	Board foot volume[2]
			inches					*per acre*			*per acre*	
Apache												
1	Ig.	Sponseller	8	26	14	0.73	80	844	102	4.7	3.76	10,266
2	Ig.	Sponseller (90%)										
	Ig.	Brolliar (10%)	6	24	13	.71	70	408	58	5.1	3.57	3,779
Coconino												
3	Sd.	Soldier	9	26	17	.73	85	589	127	6.3	10.12	10,338
4	Sd.	Hogg/McVickers (60%)										
	Ig.	Siesta/ Sponseller (40%)	8	27	18	.73	65	658	112	5.6	9.82	5,673
5	Ig.	Brolliar	5	25	16	.72	55	501	71	5.1	3.76	4,274
6	Ig.	Springerville/ Cabezon var.	3	23	15	.71	45	442	53	4.7	4.43	1,561
Kaibab												
7	Ig.	Sponseller	8	26	17	.74	75	387	84	6.3	5.76	5,831
8	Ig.	Brolliar	6	24	14	.72	60	321	65	6.1	5.24	3,028
9	Ig.	Stoneman	2	20	9	.72	45	232	35	5.3	3.10	988
Prescott												
10	Sd.	Mirabal/Dandrea (70%)										
	Ig.	Brolliar/ Stoneman (30%)	5	23	14	.70	65	248	56	6.4	4.62	2,801
Sitgreaves												
11	Sd.	McVickers (80%)/ Colcord (20%)	6	30	20	.74	70	947	63	3.5	4.08	4,082
Tonto												
12	Sd.	Amos, Bearhead, Reynolds, Workman, and Zane	5	28	18	.72	75	513	59	4.6	5.52	2,665
13	Sd.	Cherry Creek, Colcord, Diamond Rim, Little Ranch, and Verde	4	26	17	.71	65	480	54	4.5	4.76	2,194
14	Ig.	Thunderbird/ Cabezon var.	2	24	12	.71	45	403	48	4.6	4.06	1,372

[1]Ig. = Igneous; Sd. = Sedimentary.
[2]Scribner.

Table 5.--Ponderosa pine stand tables, by 2-inch diameter size classes, for 14 soil groups on the National Forests within the Salt-Verde Basin

Diameter size classes (Inches)	Apache		Coconino				Kaibab			Pres-cott	Sit-greaves	Tonto		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	trees per acre													
seedling	403.5	177.5	170.0	206.3	277.3	192.5	125.9	100.9	103.5	82.4	675.0	229.5	209.0	187.5
2	243.2	84.4	109.3	148.9	95.3	104.4	85.4	63.3	35.4	39.2	140.0	127.5	120.0	84.9
4	110.3	71.3	120.0	133.1	40.8	48.9	58.4	53.2	32.1	33.0	50.1	53.9	58.7	47.3
6	18.9	27.6	69.7	60.9	26.6	40.5	40.6	37.0	21.8	32.9	25.9	40.7	36.9	38.4
8	17.5	18.3	52.1	48.9	22.9	31.8	26.5	23.8	14.7	21.2	18.9	24.2	22.2	27.9
10	11.5	8.4	24.3	28.1	9.0	8.5	15.7	16.2	12.2	13.3	11.9	15.8	13.7	8.3
12	8.7	5.3	18.2	11.6	8.7	5.6	13.9	12.6	4.9	9.9	9.3	9.5	9.0	5.3
14	7.5	4.5	8.8	4.7	4.8	3.7	6.2	5.2	3.1	7.0	4.5	5.2	4.9	3.5
16	5.1	2.8	3.7	4.1	3.9	1.8	4.2	3.1	1.5	3.4	3.9	2.4	2.3	1.7
18	4.5	2.2	2.6	3.0	3.3	1.3	3.1	1.4	.9	2.2	2.0	1.7	1.6	1.3
20	3.7	1.8	2.3	2.5	2.6	.7	2.8	1.6	.8	1.0	1.7	.8	.8	.6
22	3.8	1.6	1.9	2.3	2.7	.9	1.7	1.0	.4	.6	2.2	.6	.5	.6
24	3.2	.6	1.8	1.8	1.2	.6	1.2	.6	.2	.3	.6	.3	.3	.6
26	1.2	.5	1.2	1.0	.9	.3	.7	.5	.1	.3	.6	.3	.3	.4
28	.8	.3	1.3	.5	.5	.2	.6	.2	0.0	.2	.4	.1	.1	.2
30	.7	.4	.8	.4	.1	.2	.1	0.0	0.0	0.0	.1	.1	.1	.1
32	.1	0.0	.3	.3	.1	.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	.1	0.0	.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0		
36+	0.0	0.0	.1	0.0	0.0	0.0	0.0	0.0	0.0					

[1]A "0" indicates between zero and .1 tree per acre.

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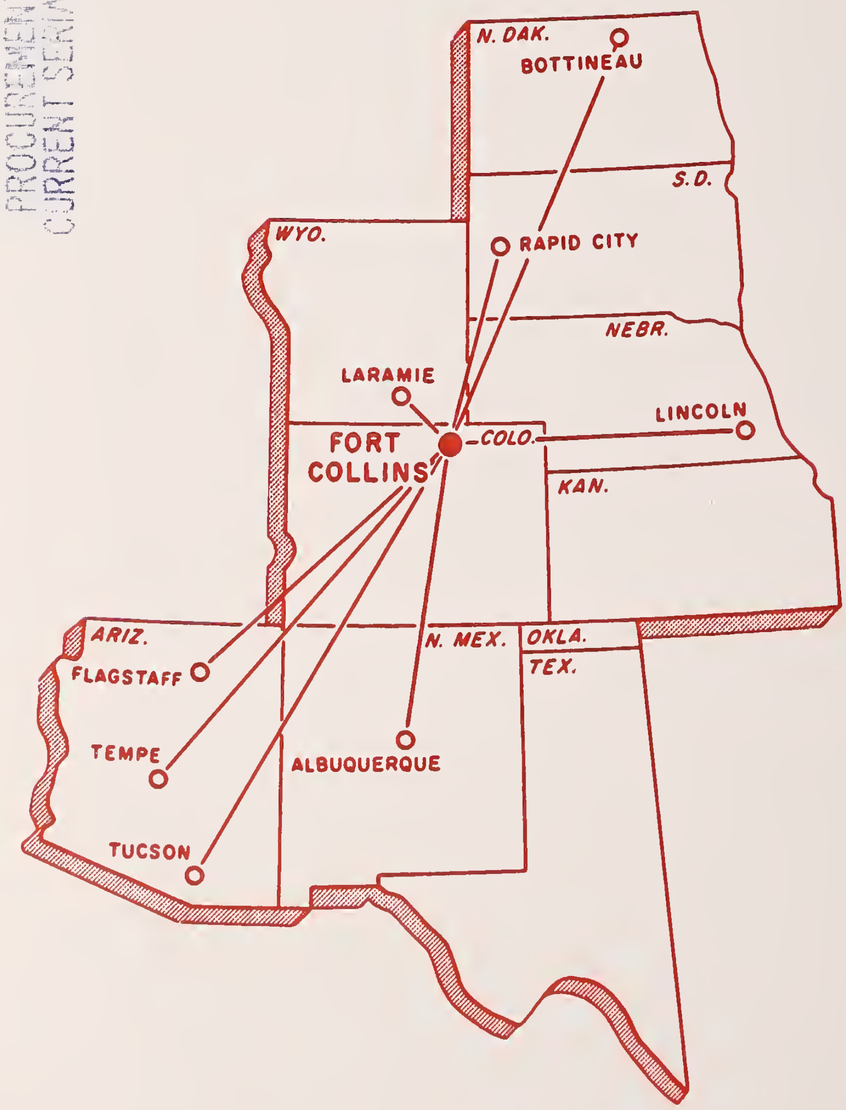
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